

Biofuels and TDOT: Connections and Initiatives

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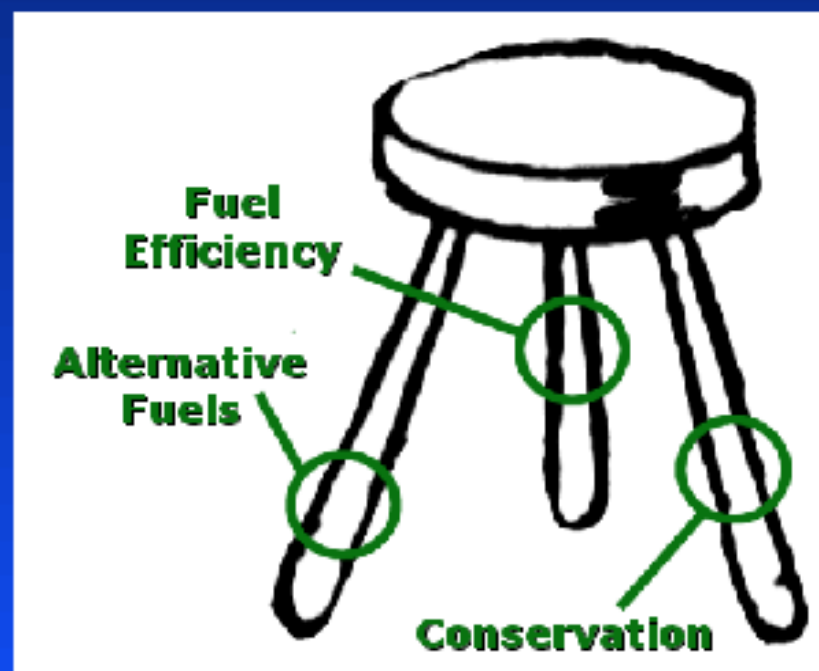
TDOT Environmental Division



AF101 - Very Important Facts & The 3-legged Stool

**#1. All
alternative fuels
have pros *and*
cons.**

**#2. We will never
replace all our
diesel with
biodiesel or our
gasoline with
ethanol.**



What are Biofuels?

- Clean, homegrown, renewable fuels
- Produced from range of natural materials
 - Farm crops (soybeans, corn, switchgrass)
 - Biomass (corn stalks, cobs, forest waste)
 - Restaurant grease
 - Animal fats
 - Municipal solid waste



Two Primary Biofuels: Ethanol and Biodiesel

- Ethanol (gasoline vehicles)
 - Produced from grains and may be produced from biomass
 - Blended with unleaded gasoline
 - E85 used in flexible-fuel vehicles (FFVs)



- Biodiesel (diesel vehicles)
 - Produced from vegetable oils, used restaurant grease and animal fats
 - Blended with petroleum diesel

Benefits of Biofuels

- Produced from renewable U.S. resources
- Reduce dependence on oil, especially imported oil
- Improve air quality
- Increase farm income
- Stimulate rural economic development



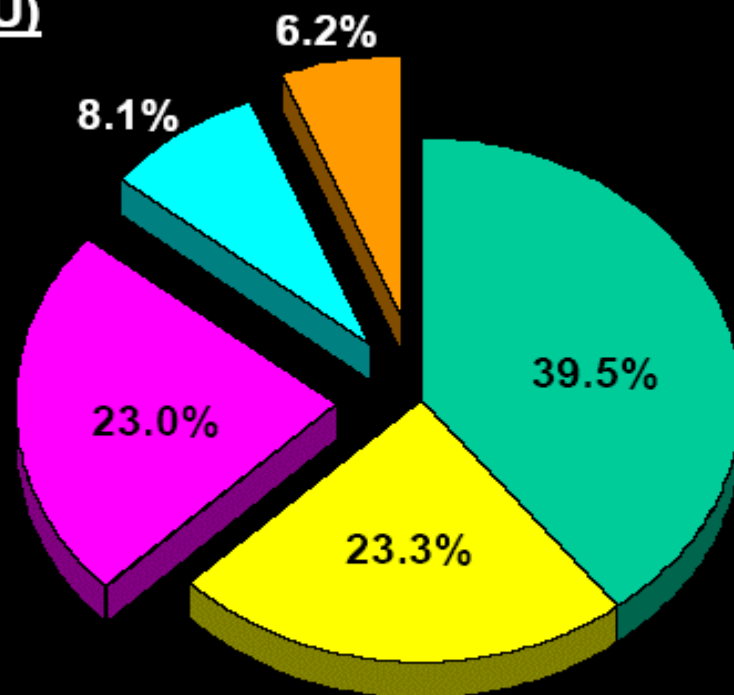
Domestic, Renewable Fuels

- Benefits for national security and economy
- Biofuels could replace 25-30 percent of U.S. oil consumption within 30 years
 - U.S. Department of Energy
 - 25 by 25 Report



2003 U.S. Energy Consumption by Fuel

	Consumption (Quadrillion BTU)
Petroleum	39.0
Natural Gas	23.0
Coal	22.7
Nuclear	8.0
Renewable	6.1
Total	98.8

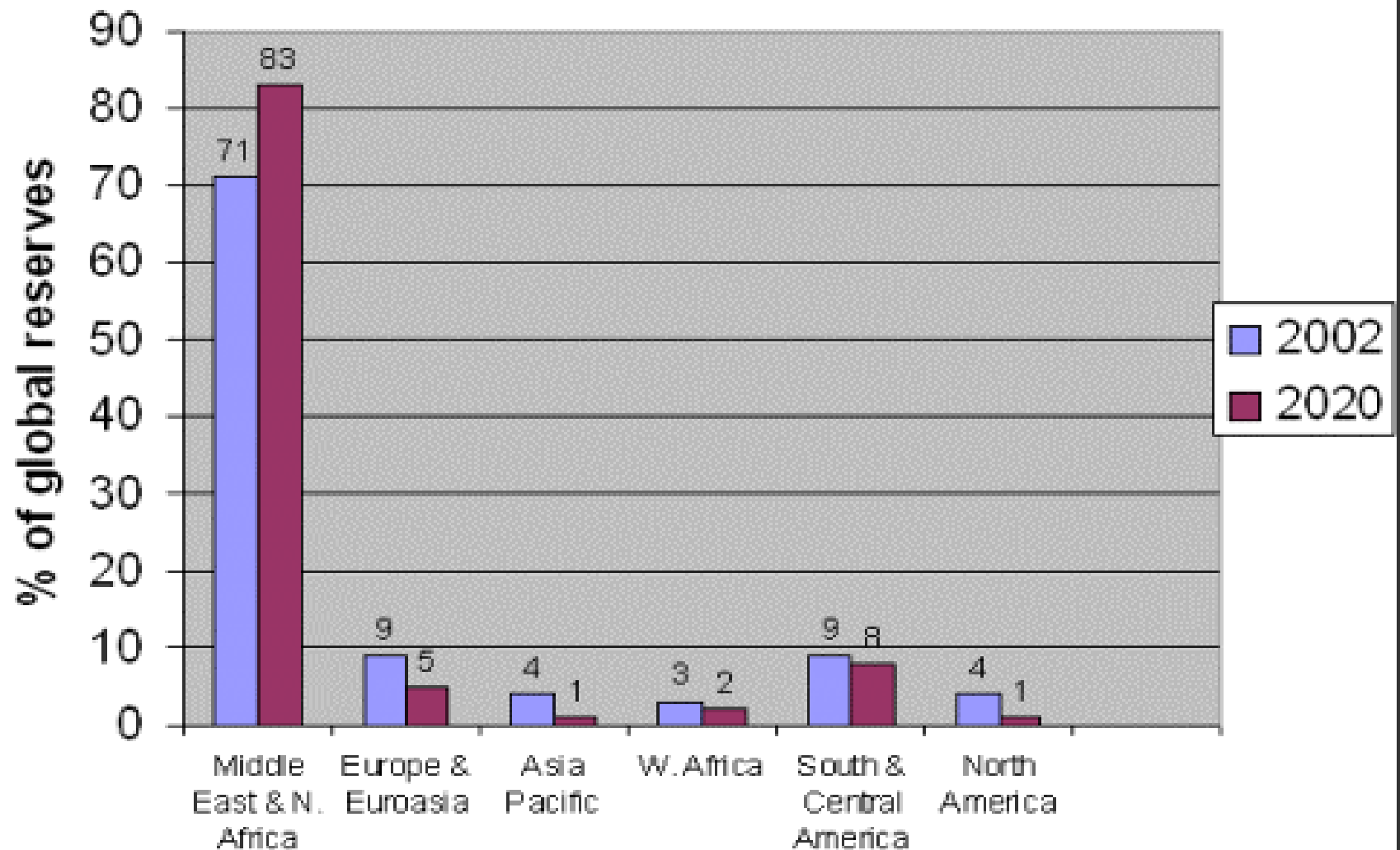


Source: Energy Information Administration

Dependence on Oil

- U.S. imports more than 60% of the petroleum we use
- Today, 66% of global oil reserves are controlled by Middle Eastern regimes
 - Saudi Arabia - 25%
 - Iraq - 11%
 - Iran - 8%
 - United Arab Emirates, Kuwait and Libya - 22%
- By 2020, this will increase to 83% of global oil reserves

Share of global reserves based on current production rates



Based on projection of 2002 production levels, BP Statistical Review of World Energy

Hubbert's Oil Peak

- At some point, world oil production will fall, never to rise again
- In 1956, M. King Hubbert predicted that U.S. oil production would peak in the early 1970's
- Although widely criticized, Hubbert's prediction came true in 1971
- Hubbert's methods predict a peak in world oil production less than five years away
- Range of estimates for timing of the oil peak
 - Within 5 years
 - Within 5-15 years
 - More than 20 years

Energy Independence Strategies

- Biofuels are part of the solution
- Fuel efficiency (e.g., Prius hybrid, plug-in hybrids, clean diesels)
- Energy conservation (drive less)



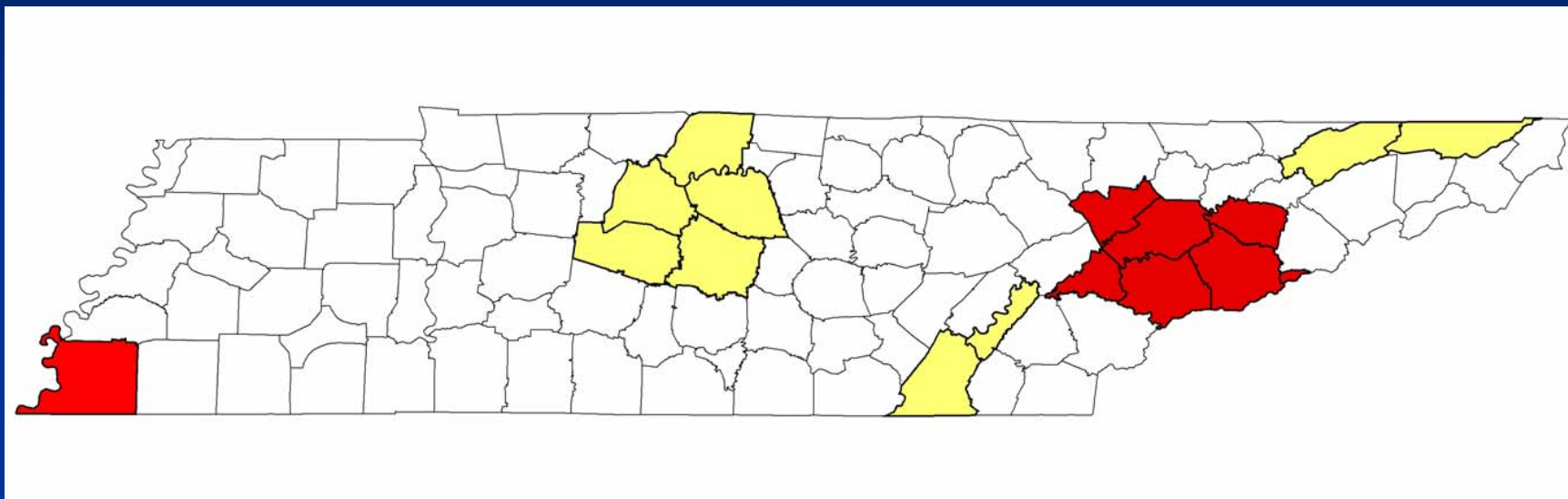
EPA Clean Air Health Standards and Nonattainment Areas




- Federal Clean Air Act directs EPA to set standards for air pollutants that affect human health
 - National Ambient Air Quality Standards (NAAQS)
 - Carbon monoxide, nitrogen oxides (NO_x), sulfur dioxide, lead, particulate matter (PM), ozone
- EPA designates nonattainment areas
 - Measured air quality exceeds standards
 - Emissions in one county affects air quality in an adjacent county

Air Quality in Tennessee

- 17 counties nonattainment for ozone
 - Anderson, Blount, Cocke (partial), Davidson, Hamilton, Hawkins, Jefferson, Knox, Loudon, Meigs, Rutherford, Sevier, Shelby, Sullivan, Sumner, Williamson and Wilson
- 6 counties nonattainment for PM 2.5 (microscopic particles)
 - Anderson, Blount, Hamilton, Knox, Loudon and Roane (partial)

Ozone Nonattainment Areas

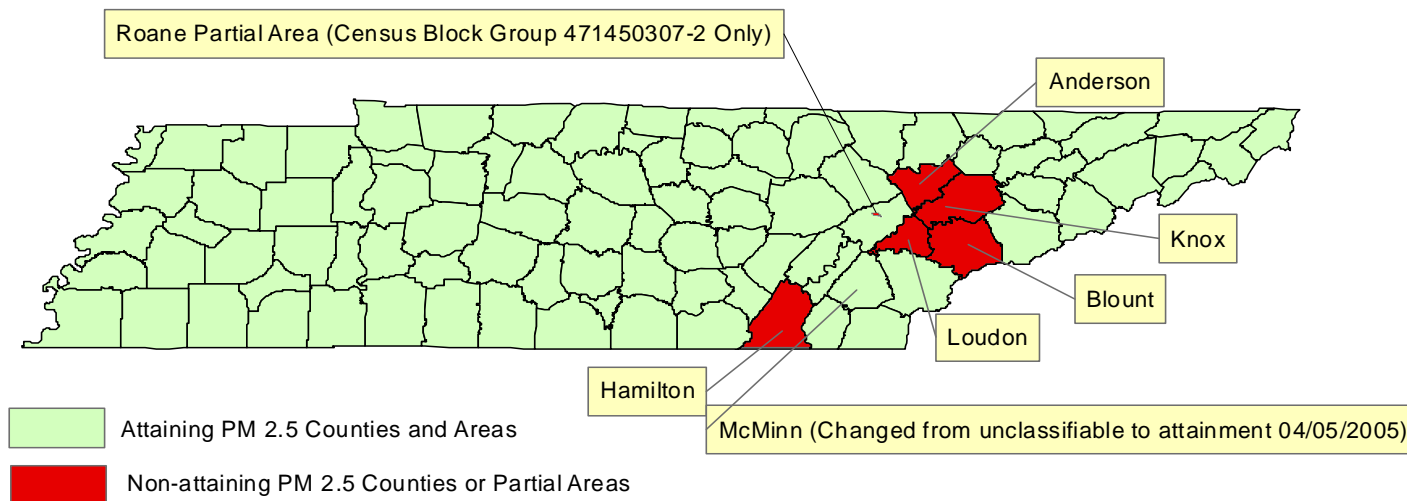


-  non-attainment but with deferred effective date – Yellow (EAC areas)
-  non-attainment with no deferral – Red
-  attainment - White



PM 2.5 Nonattainment Areas

Tennessee PM 2.5 Designations By EPA
Effective April 5, 2005



Mobile Sources of Air Pollution

- Mobile sources - major contributors to air quality problems
- Onroad sources
 - Trucks, buses, SUVs, cars, motorcycles
- Nonroad sources
 - Rail locomotives, watercraft, planes, construction equipment, lawn equipment
- Heavy-duty diesel engines particularly significant

Biofuels Reduce Air Pollution

- Using B20 or E85 reduces emissions of several pollutants
 - Ozone-forming chemical compounds
 - Oxides of nitrogen (NO_x)
 - Unburned hydrocarbons
 - Carbon monoxide
 - Particulate matter
 - Toxic substances
 - Greenhouse gases

Benefits to Farmers

- Huge and growing market for farm products
- Economic opportunity to supply significant portion of nation's Food, Fiber and Fuel
- Increase demand for agricultural products (e.g., corn and soybeans) and increase farm income
- Potential for new crops (e.g., switchgrass) in areas not suitable for corn or soybeans



Economic Benefits of Biofuels

- Significant economic benefits to the state
- Create opportunities for rural economic development and increase rural income
- Create jobs and build rural communities
- Reduce transportation costs for these cleaner fuels

Economic Benefits of Biofuels

continued

- Positive impact on local economies near biofuel production plants
 - Employ local people
 - Purchase local crops
 - Expand local tax base



Economic Benefits of Biofuels

continued

- An average-sized ethanol plant
 - Employs about 40 people with good-paying, high-skill jobs
 - Provides spin-off jobs through local providers of goods and services for the plant



What Is Fuel Ethanol?



- Ethanol is a clean-burning, high-octane fuel
 - Also known as ethyl alcohol or grain alcohol
- Produced from starches and sugars
 - crops such as corn, switchgrass or sugarcane
 - biomass sources such as corn stalks, cobs and leaves and forest waste
- Ethanol is typically blended with unleaded gasoline

Most Common Ethanol Blends

- E10: 10% ethanol and 90% unleaded gasoline
 - Approved for use in any gasoline vehicle with no engine modifications
 - In 2004, about one-third of America's gasoline was blended with ethanol, most as E10
 - No significant net air quality benefits
- E85: 85% ethanol and 15% unleaded gasoline
 - E85 used only in vehicles with special equipment: Flexible Fuel Vehicles (FFVs)
 - E85 reduces emissions of several air pollutants

Flexible Fuel Vehicles (FFVs)

- Operate on any blend of ethanol and gasoline from 85% ethanol to 100% gasoline
- Many major automakers produce FFVs (Ford, GM, Daimler-Chrysler, Nissan)
- State agencies and utilities required to buy alternative fuel vehicles
 - Federal Energy Policy Act of 1992 (EPAct)
 - TDOT has about 845 FFVs across the state
- FFV equipment costs car manufacturers about \$100 per vehicle
- Little to no additional cost for FFVs
- Retrofits not recommended

How To Identify FFVs

- Over 5 million FFVs on U.S. roads today
 - 60,000 to 80,000 FFVs in Tennessee
- Big Three to build 2 million FFVs a year
- Find out if you are driving an FFV
 - Check the label on the inside of the fuel door
 - Check your vehicle owner's manual
 - See www.E85fuel.com



E85 Disadvantages

- Ethanol has less energy content than gasoline
- FFVs may experience a 10% - 25% drop in fuel economy, depending upon the vehicle and driving habits
- Limited availability
 - Need more retail fueling locations

Biodiesel

- U.S.-produced renewable fuel that meets national fuel quality standards
- Made by transforming feedstocks
 - Virgin vegetable oil such as soy oil
 - Recycled greases such as used cooking oils
 - Animal fats
- Pure biodiesel is nontoxic and biodegradable
- Biodiesel provides vehicle performance and maintenance advantages
 - Biodiesel has superior lubricity (slipperiness) characteristics which reduce engine wear and tear
 - Some users report an increase in fuel economy

Biodiesel Reduces Emissions

(from NREL 2001)

<u>Pollutant</u>	<u>B20</u>	<u>B100</u>
• Carbon dioxide (CO ₂) <i>life-cycle</i>	- 15%	- 75%
• Carbon monoxide (CO)	- 13%	- 43%
• Hydrocarbons (VOCs)	- 11%	- 56%
• Nitrogen oxides (NO _x)	+ 1-2%*	+ 6%
• Sulfur dioxide (SO ₂)	- 19-20%	- 99%
• Particulate matter (PM)	- 12-18%**	- 55%
• Carcinogenic compounds	- 20%	- 80-90%
• Air toxics	- 12-20%	- 60-90%

* With a low-NO_x additive, can be a 5-40% reduction. Studies show reductions in NO_x in new engines w/o additives.

** Over 90% of diesel PM is PM-2.5 or smaller, with about 70% being 1 micron or smaller in size.



Biodiesel Blends

- Biodiesel fuel typically blended with petroleum diesel
- B20 most common blend (20% biodiesel and 80% petroleum diesel)
- Some diesel owners use lower blends (B5 and B10) and some use higher blends (B30, B40 and even B100)
- Blends up to B20 can be used in most diesel vehicles and equipment without engine modifications

Biodiesel - B20

- Some engine manufacturers have officially endorsed only blends up to B5 for their engines
- Others endorse blends up to B30
- Many fleets in Tennessee and elsewhere have successfully used biodiesel for years
 - North Carolina DOT, Knoxville Area Transit, Eastman Chemical, Alcoa Aluminum, Shelby County, City of Chattanooga
- Depending on fuel markets, B20 may cost a few cents more per gallon to a few cents less than petroleum diesel

Biodiesel and Older Engines

- Check with vehicle manufacturer before fueling with biodiesel
- In older vehicles, biodiesel blends greater than 20% can affect fuel hoses, gaskets and pump seals made from certain elastomers
- Biodiesel-compatible elastomers required for use with B100 and other high-percentage blends
- Reduced effect with lower blends (B20 or lower)

Maintenance Issues

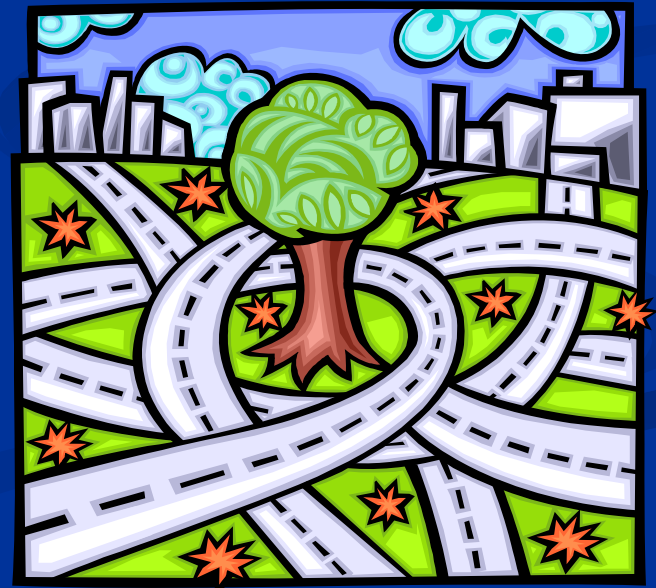
- Check fuel filters when first using biodiesel
- Special measures required for all diesel fuel in cold weather
 - Biodiesel has higher cloud point than petroleum diesel
 - Cold weather methods for petroleum diesel will also work for biodiesel blends
 - Use of anti-gelling additives
 - Blending with No. 1 diesel

Fuel Quality

- To protect engines and ensure trouble-free operation, B100 blended with petroleum diesel must meet national fuel quality specifications (ASTM D6751)
- Tennessee Department of Agriculture tests biodiesel to ensure that it meets quality standards

TDOT Connections

- Cleaner transportation for Tennessee
- Responsibility to help reduce mobile source emissions
- Cleaner fuels one important strategy
- Lead by example



TDOT Alternative Fuel Initiatives

- Governor's Executive Order #33
- Biodiesel use in TDOT Diesels
- E85 use in TDOT FFVs
- Biofuels retail infrastructure project
- Metro Transit Authority biodiesel grant
- Southeast Alternative Fuels Task Force
- Partnerships

Executive Order #33

- Governor Bredesen signed February 2006
 - Directs state agencies to use E85 and B20 in state vehicles whenever possible
 - Established the Governor's Interagency Working Group on Alternative Fuels
 - Working Group to develop recommendations to make the state a leader in the Southeast in the production, distribution and use of biofuels

Executive Order #33 continued

- Governor asked General Assembly for an extra \$4 million to support biofuels
 - Feedstock processing
 - Retail infrastructure
 - Public education and outreach



B20 Region 1 Pilot Program

- TDOT B20 pilot program in Region 1 announced December 16, 2005
- Region 1 staff identified 133 on-road vehicles for the pilot
 - 99 diesels in Knoxville, including 13 HELP trucks
 - 34 diesels in Johnson City
- Switched three fueling sites to B20
- TDOT began using B20 in on-road diesel vehicles in Knoxville and Johnson City

B20 Region 1 Pilot Results



- About 125 TDOT on-road diesel vehicles, including dump trucks and HELP trucks, have run on B20 for almost a year
- B20 performance has been excellent
- TDOT's pilot was the first widespread use of biodiesel in state vehicles
- Warranty vehicles in the B20 pilot were switched back to petroleum diesel because of engine manufacturer warnings

Expanding B20 Use Across the State

- Commissioner Nicely directed that TDOT begin using B20 in other regions
 - Regions 2, 3 and 4
 - Selected districts
 - Memphis



E85 Use in TDOT FFVs

- Commissioner asked TDOT employees to use E85 in TDOT FFVs when possible
 - In Nashville and Region 3 now
 - In other areas when E85 becomes available
- Over half of TDOT's light-duty vehicles are FFVs capable of running on E85
- Please check your TDOT vehicle to see if you are driving an FFV
- If you drive an FFV, please use E85

E85 Outreach

- Distributed TDEC E85 brochure to motor pools
- Obtained E85 key chains, mirror hangers and bumper stickers for FFVs
- *Journeys* article on E85
- Commissioner's Friday email on E85
- E85 bookmark
- Brown Bag PowerPoint presentation

Biofuels Retail Infrastructure CMAQ Project

- TDOT is working with retail fuel stations to set up B20 and E85 refueling locations across the state
- Establish statewide network of publicly accessible refueling pumps
 - Focus on interstate corridors
- Publicly accessible fuel stations will allow more citizens and private and government fleets to use biofuels

Biofuels Retail Infrastructure

CMAQ Project continued

- Help retail stations convert or install biofuels storage tanks and fuel pumps
- 80/20 cost-sharing
 - 80% funding from Congestion Mitigation and Air Quality Improvement (CMAQ) Program
 - 20% nonfederal match from fuel station

Metro Transit Authority Biodiesel Grant

- TDOT grant to Nashville Metro Transit Authority (MTA) to use B20 in 18 MTA transit buses
 - Pilot project funded by TDOT's Public Transportation, Waterways and Rail Division
- MTA views project as complete success and wants to convert all buses to biodiesel
- Cost of B20 is barrier to expanded use

Southeast Alternative Fuels Task Force

- TDOT will continue to work with the Southeast Alternative Fuels Task Force to increase the availability and use of alternative fuels in the region
- Establish corridor network of biofuel stations along interstate highways that link major destinations in four states
- Georgia, North Carolina, South Carolina and Tennessee

Partnerships

- TDOT is working with a variety of partners to encourage local government and private sector vehicle fleet managers to use B20 and E85
 - Other state agencies
 - Clean Cities coalitions
 - Regional clean air partnerships

Additional Resources

National Biodiesel Board

www.biodiesel.org

National Ethanol Vehicle Coalition

www.e85fuel.com

Renewable Fuels Association

www.ethanolrfa.org

American Coalition for Ethanol

www.ethanol.org

Governors' Ethanol Coalition

www.ethanol-gec.org

U.S. DOE Alternative Fuels Data Center

www.eere.energy.gov/afdc

Clean Fuels Development Coalition

www.cleanfuelsdc.org

General Motors Live Green Go Yellow

www.gm.com/company/onlygm/livegreengoyellow/index.html

Tennessee Department of Transportation

www.tdot.state.tn.us/biofuel

Tennessee Alternative Fuels

<http://test.state.tn.us/environment/altfuels>

Finding E85 and B20

Stations located across U.S.

www.e85refueling.com

www.biodiesel.org/buyingbiodiesel/retailfuelingsites

866 BIODIESEL Toll Free Number - National Biodiesel Board

In Nashville

E85 and B20

Main Street Citgo
500 North Main
Nashville, TN 37206
(615) 244-3828

In Knoxville region

www.etcfc.org

In Clarksville

E85

Shell Sudden Service
110 Needmore Rd.
Clarksville, TN
(931) 648-4771

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